Fall Final Report (FFR) Assignment

ASEN 4018, Senior Projects I: Design Synthesis
Fall 2013

1.0 Document Scope

This document specifies the required elements and deliverables for the Fall Final Report for ASEN 4018.

2.0 Report Objective and Scope

The Fall Final Report is a comprehensive documentation of the design synthesis portion of the Senior Projects course. It is a counterpart to the Critical Design Review, but has distinct objectives:

- Complete picture: while the CDR material was restricted to the most important design issues (due to limited presentation time), the FFR should discuss all the critical elements in the project.

- Documentation archive: the FFR provides a central collection of all relevant documentation in the project as a basis for further project development in the Spring term.

The FFR must stand alone as a complete description of the project through the CDR phase of development. It must include a clear description of the purpose of the project, along with the customer's functional requirements and the specific project objectives (measures of success). It must present a requirements flow-down from functional requirements to detailed design requirements. It must describe the design solution from the top down to design details sufficient to specify what components to purchase and how to fabricate components that will be manufactured in house. It must show how the design solution is capable of meeting the design requirements. It must describe how models were constructed and used to develop the design, and to identify specific criteria for characterizing the prototype in verification testing. It must describe the functional testing that will provide validation of the design against the functional requirements. It must identify the remaining risks in the project, along with contingencies to mitigate these risks. And finally, it must present a plan for carrying out the build and test phases of the project, identifying specific work products, scheduling of associated tasks, and budgeting the available resources.

3.0 Required Structure and Authorship

All members of the team should make a significant contribution to the FFR in terms of both content and actual writing. The report should follow the organizational structure defined below, with corresponding named chapters in the report. Within each chapter, you are free to organize the discussion as it best describes the particulars of your project. This typically does not lend itself to clean divisions among team members with respect to authorship, however, since many of the efforts on the project are highly collaborative. Accordingly, to provide a fair assessment of member contributions, the report will contain a contribution summary section, organized by team member, describing their specific content and written contributions to the FFR.

4.0 Final Report Data Package

4.1 FFR Data package Content

The Fall Final Report consists of two volumes:

1) Written report named according to: TEAM_FFR.docx [must be a Microsoft Word document].
2) Electronic documentation archive, organized by project sub-systems, containing all relevant and up-to-date diagrams, drawings, schematics, source code, product spec sheets, images, videos, etc.

needed to carry the project forward. Any of these items used in the written report must be inserted into the report to make it self-contained and readable, but reference to specific archive items can be made for more detail. Each archive sub-section should contain a Word file with a short summary of its contents.

4.2 Required Written Report Content

The written portion of the Fall Final Report is a comprehensive technical report that collects all the work conducted on the design through CDR into a readable whole. It contains information and ideas already delivered in the PDD, CDD, PDR, and CDR, together with detailed design work not presented in the CDR. Hence, much of the information required in the FFR has already been developed. However, the FFR must be an organized, concise description of the project from the more knowledgeable vantage point at the end of the first semester. Accordingly, the earlier design products must be revised, edited, and re-evaluated in many cases to contribute to a cogent project description in the FFR, rather than simply a collection of previous work that may confuse the reader or convey a poor understanding of the project. With this proviso, as much of the previous work as possible should be re-used in the FFR.

A comprehensive report covering the extensive amount of work accomplished by a team of engineers over many months is a challenge to organize, but good organization is essential to avoid losing the reader and hence the impact of your work. Generally, provide a road map in the early parts of a section saying what will be covered and why, and link it to previous or following sections. Provide context before content, an overview before the details. Use diagrams to place a concept of the idea in the reader's mind before delving into wordy detail or analysis. As in presentations, where each slide should make a point, each paragraph in a report should make a point, often aided with diagrams, equations, plots, etc. You may find it useful to outline the report down to the level of the point each paragraph should make, before filling in the detail. This also helps with organizing who will write what sections in the report, and with integrating sections written by different team members into a cohesive whole.

Be concise in your descriptions, stating the ideas directly, with simple language. Give all parts of the system unique names to promote clarity of discussion. Label diagrams with these names. Connect analytical methods and approaches with the needs of the project. Connect equations with corresponding diagrams, numerical results, and descriptions. Use unique symbols in analytical work, and the same symbols in associated diagrams and descriptions. Use technical terminology correctly and consistently.

Finally, and most importantly, the FFR should explain how the system works. Don't obscure your understanding of the engineering issues by piles of unrelated detail, bureaucratic filler, meaningless plots, unexplained diagrams, unlabeled pictures, etc. Provide conclusions for pieces of this work, explaining the meaning of the results to the needs of the project. Don't just describe "what", say "why". Address your discussion to a generally knowledgeable professional engineering audience, but don't assume the reader knows how or why your system works.

The top-level organization of the written report shall have the following structure:

Preamble

- Title Page, including project title, names of all group members, customer, advisor, and date.
- Table of Contents
- List of Figures
- List of Tables
- List of Acronyms
- Definition of symbols (nomenclature)

Section 1: Project Purpose

Describe the field of application, the problem addressed, and the predicted benefits of a successful project. Place the problem in context with other work. Clearly identify what is novel about the project. Cite references to the engineering literature, popular press, or web sites as appropriate. Do not cite any proprietary documents or personal communication that is not available in the public domain.

Section 2: Project Objectives and Functional Requirements

Describe specifically what the project must accomplish to satisfy the design problem or need, and thereby what "success" means for your project, using levels ranging from the absolute minimum that must be accomplished for the project to be considered a success (Level 1) up to the most that the project will *plan* to accomplish (Level N). Illustrate the operation of the system in this application and in the course with CONOPS diagrams. Include an explicit description of the project deliverables to the course and to the customer.

Provide a functional block diagram (FBD), along with its explanation. It should include the major elements of a functioning system, and how they must interact to solve the problem. It should also show which elements or aspects will be designed by the team and which elements will be supplied or acquired. In many cases, the senior project will address only a portion of a larger system or problem; the FBD should distinguish the project elements from others in a larger system. Provide a numbered list of the functional requirements for the project, with an explanation of the source and rationale for each.

Section 3: Conceptual Design

Describe the set of conceptual design alternatives considered. Describe each option in enough detail to explain how it works, including a diagram and a brief list of pros and cons relative to the project functional requirements and success objectives.

Describe the set of trade studies conducted to narrow the concept alternatives down to a baseline conceptual design. Describe the rationale for the particular trade studies conducted. Explain the design effects considered and how they were identified. Describe the methodology for assigning weightings on the effects, and the approach for assigning values for the design options. Provide a trade matrix for each study conducted. Discuss how the results of trade studies were evaluated, and how that led to the baseline design selection.

Describe the baseline design, showing what the whole system looks like, its key parameters (dimensions, mass, data rates, etc.), what the major elements or subsystems are, and most importantly, how it works. This is a top-level description that provides the context and terminology for more detailed descriptions later in the report.

Section 4: Requirements Development

Describe the requirements flow-down from functional requirements to detailed design requirements. Use a requirement numbering system to indicate parent/child relationships among requirements. Describe the rationale for each requirement, i.e. how it flows logically or technically from the parent requirement, or why the child requirement makes sense as a designer's choice in the context of the objectives of the project.

Section 5: Detailed Design

Describe how the design details were developed to satisfy design requirements. Organize this section according to sub-system divisions in the project to collect related design elements and to make the description easier to follow. Describe the models that were developed, and how they were used to assist in these design decisions, including modeling results and their implications where appropriate. To limit the length of this discussion, focus on the critical project elements,

showing how the design satisfies the associated design requirements. Don't just show the design details, but explain how they work to satisfy the requirements using drawings, diagrams, schematics, flow charts, etc. Provide engineering design detail and quantification to convey your understanding of all critical design elements and the corresponding design solutions.

Section 6: Verification and Validation

Describe how the design will be verified against predictive models through characterization testing. Use diagrams to convey the test set up, the facilities and equipment needed, and how the test works. Describe the measurements to be made, and key measurement issues (resolution, sampling rate, etc.) Show how the selected sensors, instruments, data acquisition, test fixtures, etc., provide the required capabilities.

Describe how the design will be validated against functional requirements and overall project success criteria.

Section 7: Risk Assessment and Mitigation

Identify specific risks in the project to achieving project objectives. Address technical, logistic, safety, and financial aspects of risk in the development of the design into a prototype and its testing. Place these risks in a matrix indicating their likelihood of occurrence versus the severity of consequences to project success. Discuss credible mitigations of risks that are likely and/or severely consequential, along with the impact of these mitigations on project success.

Section 8: Project Planning

A clear plan for carrying out the project in the Spring term is required. Your discussion should include the following planning components:

- Organizational Chart (OC), showing the leadership roles of all team members.
- Work Breakdown Structure (WBS), showing all the work products for the project. Explain how the work products were determined.
- Work Plan (WP), showing the main tasks to accomplish the WBS products, along with their scheduling, in the form of a Gantt chart. Describe critical path tasks, and discuss how schedule margins were allocated.
- Cost Plan (CP), in the form of a financial budget, for all major items in the project, highlighting uncertainties and corresponding budget margins.
- Provide a Test Plan (TP) showing all major tests to be conducted and how they are scheduled. Note the use of specialized test equipment or facilities for which access is limited, and show that your access to these is feasible.

Section 9: Individual Report Contributions

Briefly describe the contributions of each team member to the FFR, including both design work (content) and the writing itself. Each team member should write this for themselves, drawing upon information already provided in the post-CDR self-evaluations.

4.3 Written Report Format

The written report shall conform to the following standard format.

4.3.1 Font

The text of your report must use 11 point Times Roman font, 1.15 line spaced. Remember: Easy reading makes grading easier! Advisers are human too.

Other fonts (Helvetica or Arial) may be used for headings, figure captions, table captions, and figure labels. Figure labels should be at least 10 point font size.

4.3.2 Margins

Use 1 inch margins on all sides.

4.3.3 Figures

Figures must be included within the text, following their first reference within the text. Do not include figures that are not also referenced within the text.

4.3.4 Tables

Tables must be included within the text, following their first reference within the text. Do not include tables that are not also referenced within the text.

4.4 Delivery Instructions

The data package must be submitted in the following two forms. Hand delivery is preferred, but copies can be left in your LM Mailbox with an associated e-mail to your advisor and course coordinator about their deposition. The team is responsible for delivery to the Advisor/CC.

4.4.1 **Hardcopies:**

One hardcopy of the written report must be submitted by the deadline for team advisor grading. **Spiral binding is preferred**.

4.4.2 **DVD**:

The DVD shall contain all the files of the package described in **4.1.**
Two DVD's are required: one (1) for the Course Coordinator and one (1) for the team advisor.
It is recommended to make one for the team as well.

4.5 Due Date and Time

All materials must be provided to the course coordinator and project advisor no later than **4:00 PM, Monday, December 15, 2014**, either personally, or in the team mailbox in the LM room.

4.6 Cost

Teams should limit costs to print and bind their reports. Use color pictures only when necessary.

NOTE: The FFR has extreme value to show in a job interview. It is therefore suggested that the team also print one hard copy of the FFR report to share by those who travel to interviews.

5.0 Grading

The FFR will be evaluated by your advisor, who will recommend a group grade to the PAB based on the section weightings given below. The team reports and grades will be discussed by the PAB to resolve any grading inconsistencies, and the PAB will issue a group grade for each team's FFR.

Individual grades on the FFR will be derived as differential adjustments from the group grade, based on advisor assessments of individual contributions, peer evaluations, and the stated individual contributions to the report (Section 9). Any individual adjustments will preserve the group grade as the average of the individual grades in a group.

Section 1: Project Purpose (5%)
Section 2: Project Objectives and Functional Requirements (5%)
Section 3: Conceptual Design (10%)
Section 4: Requirements Development (15%)
Section 5: Detailed Design (30%)
Section 6: Verification and Validation (10%)
Section 7: Risk Assessment and Mitigation (5%)
Section 8: Project Planning (10%)
Section 9: Individual Report Contributions (0%)
Overall writing quality (10%)